

The Development of Communications Law for Cognitive Wireless Networks in the Age of Artificial Intelligence and Digital Connectivity

Amalia Zuhra¹, Wildani Angkasari²

^{1,2}Senior Lecturer, Faculty of Law, Universitas Trisakti, Jakarta, Indonesia

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ABSTRACT

To ensure an economy that runs on technology runs effectively, new technologies may also create new economies. That is why it's important for these new technologies to follow the direction of humans as a center of technology. Therefore, policies and standards for both the Internet of Things and Artificial Intelligence must be established in order to best utilize the positive aspects of technology and avoid, or mitigate, the negative effects that could arise due to misuse. One area where technology is proving increasingly useful is in the area of the internet. Because of the rapid growth of mobile social media, the placement of online public opinion monitoring into traditional public opinion monitoring has become more prominent, than at any time in the past. There are various topics concerning the internet public opinion regulation, many different types of objects regarding this area of concern, many different communication channels, an instant delivery of communications; two-way communication, etc. Each of these elements creates distinct features of Internet public opinion regulation, but also creates a number of associated issues, such as online rumors, invasion of privacy of others and the expression of private rage. Ultimately, the combination of artificial intelligence and digital health (AI-DH) may create a more accessible, responsive and fair health care system; however, the ultimate success of this combination will depend upon the ability to balance advances in technology with the degree to which patients have confidence in the technology, the degree to which the technology will protect the patient and the level of readiness of the community for the new technology. As technology continues to grow, cognitive wireless networks will continue to emerge as one of the key infrastructures of the mobile Internet.

Corresponding Author:

Amalia Zuhra,

Senior Lecturer, Faculty of Law, Universitas Trisakti, Jakarta, Indonesia.

1. INTRODUCTION

Over the last three centuries, there have been three major industrial revolutions that have radically altered human social structure. Today's world is experiencing a revolution similar to these previous revolutions, known as the Fourth Industrial Revolution. This revolution is stemmed from the rapid advancement of new technologies, many of which are considered disruptive [1]; they will

change the way we interact with our environment in new and significant ways (i.e., biotechnology, nanotechnology and robotics). In a nutshell, due to the digital revolution and the rise of artificial intelligence, computers, machines and software will no longer be viewed simply as tools used to assist humans improve their physical capability; rather, there is a massive shift occurring in the essence of the human condition and the nature of its environment. The radical changes being experienced today are driven from two primary phenomena: (1) the revolutionary transformation in the method of processing data and converting that data into meaningful information/knowledge, in many cases that could only be performed by humans, and (2) a revolutionary transformation of the concepts of time and space as experienced by humans.

The exponential increase of information and data being created every day means that we live in information and knowledge society in which the flow of information is continually changing [2]. The classic challenges we face today (ensuring that multiple rights are respected) have been made even more complex by the emergence of challenges that arise from the new reality of living in a digital society [3]. For example, we need to reduce the digital divide between those who have internet access and those who do not; at the same time, we need to make certain that every person's digital identity is protected as an element of their self-determination and human dignity [4]. As a result of the "digitalisation" of a portion of every person's existence, protecting people's digital identity becomes paramount. In response to this rapidly evolving, increasingly complex set of challenges, government and public administration agencies are faced with unprecedented challenges, which may be summarised as follows: (1) how do we internally reconfigure state power (e.g., new models, structures, systems, processes, etc.)? (2) How do we externally reconfigure our relationship with citizens? (3) How do we ensure that new technologies enhance the ability of individuals to exercise their rights and achieve sustainable and inclusive development while reducing the existing inequities that exist within society?

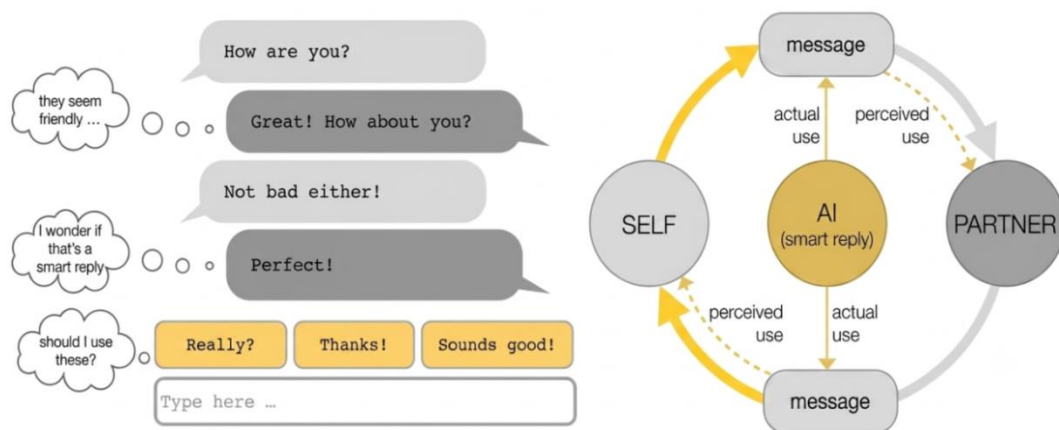


Figure 1. Example of a Message Exchange with AI support

One of the most commonly used AI features to date is the use of 'smart' suggestions for responses within a text-based communication medium and the ability for an automated reply to be provided via a person's own email program [5]. In 2017, about 12% of all emails sent through Gmail contained algorithmically generated by AI Reply of Different Messages, with approximately 6.7 Billion such emails generated by AI Daily on behalf of users. Smart reply systems use the available information from various text-Corpus as an input to predict how a human may respond to a message and generate one or multiple suggested ways in which the sender may reply to the original message as shown in Figure 1. The rapid adoption of this type of artificial intelligence for

use in one-on-one communication has occurred as a result of extensive research conducted on the many different ways that algorithmically produced reply options can be generated.

6G networks are anticipated to build upon the capabilities of 5G in terms of increasing the amount of wireless connectivity and how well we can navigate within that connectivity. 5G has provided faster data communications at lower latency, but 6G will support many more applications than 5G by providing ultra-high-speed connectivity at theoretical speeds as fast as 1 terabit per second. This increased capability will create many new use cases for technologies, such as introducing holographic communication systems, supporting autonomous devices, and enabling billions of Internet-of-Things devices to be connected within urban and rural areas. Furthermore [6], it is expected that 6G will use multiple different communication methods, including terahertz (THz) frequencies, satellite communications, and optical wireless communications, to increase speed and accuracy when transmitting data over long distances.

AI is going to help manage the complexity in these systems by providing opportunities for self-optimisation, adapting to challenges related to changes in the network and providing services in real-time to the users [7]. AI will play a large role in the management of 6G networks; one of the main areas that will benefit from 6G networks is network management. Network management has relied on humans to optimise and troubleshoot; however, with AI solutions network management becomes an automated system. Therefore, the networks will manage, optimise, detect congested areas, troubleshoot, and modify network parameters, all done autonomously with no human interaction or involvement required. Automated learning through the use of AI algorithms will also improve the efficiency and reliability of the 6G networks, allowing for greater fault tolerance and adaptability to continuously changing environmental conditions. The use of AI technology will play a key role in optimising the use of spectrum, coverage and energy efficiency for wireless communications with 6G, which will improve sustainability and allow the effective management of many devices without consuming large amounts of resources.

2. LITERATURE REVIEW

This research project also covers the scientific treatment of major EU initiatives like effective public administration, WiFi4EU, free mobile roaming, Industry 4.0, automated and autonomous vehicles, which together lay the groundwork for digital infrastructure and connectivity in the EU. The study uses a mix of analytical, synthetic, comparative and deductive techniques to examine the relationships between these initiatives, their shared objectives of enhancing technological compatibility, providing social inclusion and contributing to environmental sustainability [8], and the barriers to governance, ethics and data protection that need to be addressed. The main sources of information utilised were open access scientific publications indexed in the Web of Science and Scopus databases between 2018 and the present, and EU legislation and decisions from the European Court of Justice relating to the subject being studied.

This article reports on the impact that digital innovation—particularly in terms of the use of AI—has had on the legal profession and business transactions conducted online. It investigates the challenges posed by technology's introduction of new methods for performing legal functions using electronic or digital means. Additionally, this paper identifies the opportunities and challenges which result from technological advances. Some of the major issues discussed within the context of new electronic and digital methods for performing law are data security [9], judicial privacy, professional responsibility, and how traditional laws are adapting to meet the new digital world's requirements. It also considers how ready legal practitioners are to adopt to the changes created by

the rise of e-commerce. AI's ability to facilitate unique e-commerce related legal processes by providing access to justice at less expense and in reduced timeframes is further examined.

Using 6G networks and AI will have significant benefits and effects. The current research paper employs a conceptual approach to examining existing AI technologies employing a conceptual framework, and the foundational technologies associated with them, through literature reviews [10]. The implications of AI on 6G will provide tremendous advantages over previous generations, such as ultra-fast connectivity, real-time decision-making and data management. Increased use of AI will result in autonomous systems, improve the state of healthcare through proactive tracking of patients and significantly improve the industrial advantage with automation, and will play an important role in developing smart cities. Challenges will continue to exist around the application of complex AI systems, security and privacy issues, and establishing robust governance policies.

The paper describes how communication and AI are forming a unified force and provides a roadmap detailing the progression of both AI and wireless communication systems [11]. The authors present the main concept of ComAI, a framework that includes collecting information by sensing and gathering data; cognitive intelligent communications via 'intellicise' semantic network systems; and decision making using massive scale models. The 'intellicise' semantic network systems describe intelligent condensed communication systems that use semantics from the level of information to simplify the traditional way signal processing, cognitive information, and network organizations operate. In addition, the authors give in-depth theoretical foundations and key methods necessary for integrating AI into both communications and other fields. They also provide experimental tests, including insights from the ongoing 6G testing of these technologies, as well as possible application scenarios like using AI for embedded robotic solutions, and the use of many agents collaborating to communicate with one another.

3. METHODS AND MATERIALS

3.1 AI and Communication

Regardless of whether this is openly recognized, the core of the everyday experience within the realm of the study and practice of artificial intelligence involves the use of communication (as well as the way in which the term "communication [12]" is defined and utilized) to provide both theoretical and empirically derived evidence of how to define and evaluate machine intelligence within an academic context as well as to establish AI as an experimental science. This assertion is also supported by the seminal and infamous research paper written by Alan Turing titled "Computing Machinery and Intelligence," published in 1950, which is credited with defining the field of AI by conceptualizing a computer's ability to imitate human behavior through Turing's "imitation game," or more commonly referred to as the "Turing Test." Many scholars believe that Turing's version of the Imitation Game (which is also referenced in what is colloquially referred to as the "Turing Test") fundamentally describes the discipline of AI as a field of study. Turing proposes to examine the subject "Can machines think?" in the beginning of his article, but he quickly identifies enduring and seemingly unsolvable terminological issues with the question itself. Because of this, he suggests a different course of investigation that may be "described in relatively unambiguous words."

3.2 The Machinery of Communication

In Turing's imitation game [13], the computer took on two roles: First, the computer was the medium through which the human participants exchanged their messages and second, the participant who was the one using that medium to communicate. 26 Still, except for a few studies, communications research has limited its understanding of and approach to the computer only as a medium of communication among humans. Thus, communication researchers and theorists have done much of their work on computers as mediums of human communication.

3.3 Integration of AI-DH

A major shift is happening in healthcare, primarily due to cutting-edge technology like Artificial Intelligence (AI) and Digital Health (aka AI-DH). Based on an existing definition, AI is a powerful tool capable of performing many of the same functions or tasks that require human intelligence as well as the ability to learn from a lot of data. Digital health can also be defined as all health-related things being digitized, greatly expanding the number and type of capabilities that can be offered—such as electronic patient records and mobile apps; all supported by AI. In addition to having the imaginative potential to improve access and quality of health care, some estimates indicate that AI-DH will continue to grow exponentially over the next three to five years (i.e., as the \$23 billion dollar market by 2026). However, achieving such extraordinary outcomes presents many hurdles (i.e., technical and non-technical impediments), e.g., 1) [14] changing systems and processes so that organizations feel comfortable using AI-DH, as they relate to overall innovation; 2) overcome inherent resistance to learning and using AI as part of routine practice; 3) address the challenge of making sure that everyone has equal access to receive high-quality services.

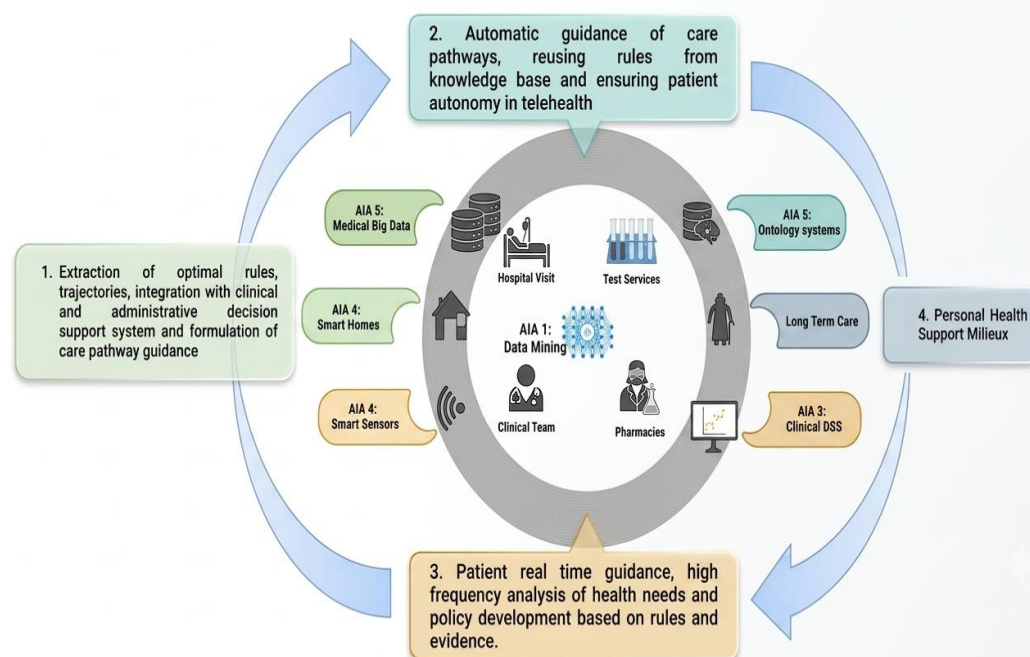


Figure 2. AI-Powered Healthcare Pathways that Combine Medical Big Data, Smart Technologies, and Data Mining To Automate Patient Counseling, Maximize Decision-Making, and Provide Customized Health Support Systems

Figure 2 illustrates how AI uses big data integration, smart systems, and data mining to help healthcare [15]. AI facilitates decision assistance for physicians and patients, extracts optimal treatment norms, and automates patient coaching. Better treatment and patient autonomy are guaranteed by the personal health support network it establishes.

3.4 Cognitive Wireless Network

The constantly developing wireless communication technology has brought more and more wireless electronic products, applications, and services. These newborn technology products, on the one hand, bring people entertainment and convenient life [16], such as personal mobile communication, intelligent car communication, smart home products, and telemedicine. This series of products make the present and future life gradually become intelligent; on the other hand, the constant data communication brings the continuous data communication with many pressures and challenges to the existing communication networks and communication resources, such as the shortage of wireless spectrum resources and its unreasonable management mechanism and the exponentially increasing data in the network.

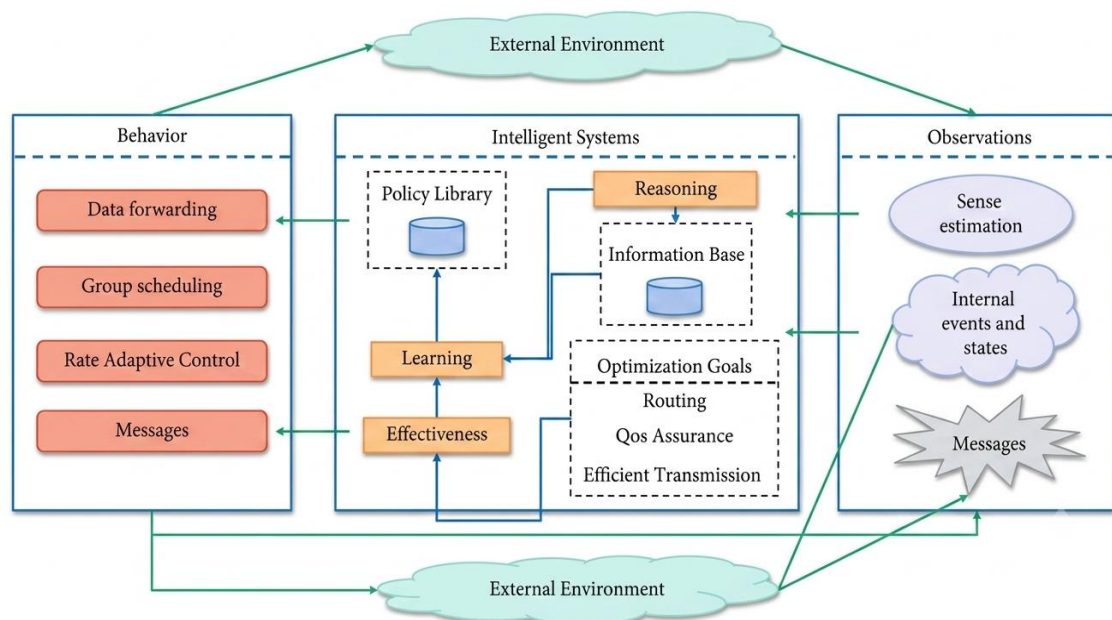


Figure 3. Intelligent Cognitive Loops

A key component in this intelligent process is the cognitive feedback loop; it determines how to proceed after considering how current actions have impacted the network to create the next action, shown in Figure 3. The concept of a cognitive network [17], much like the artificial intelligence idea system, begins with a human cognitive model of the environment and uses systematic methods to perceive environmental information, discover useful information from that environmental information, and integrate all three into an information base. All of the above actions are completed without human interaction, eventually resulting in making intelligent decisions that will help achieve the desired goals within the framework of wireless resource management, heterogeneous networks, security, and quality of service (QoS).

4. IMPLEMENTATION AND EXPERIMENTAL RESULTS

4.1. Evaluation Metrics

This study tests the performance of neural network learning models using mean square error (MSE) and regression rate (RR) in order to assess the cognitive engine. The accuracy and stability of prediction outcomes are measured by RR and MSE, respectively [18]. The definition of MSE is

$$MSE = \frac{1}{N} \sum_{i=1}^N (O_i - T_i)^2, \dots i = 1 \dots N \quad (1)$$

T_i is the i -th target value, O_i is the neural network's i th output, and N is the total number of test samples.

$$RR = \frac{\sum_{i=1}^N V_i}{M} * 100\% \quad (2)$$

$$V_i = \begin{cases} 1 & \text{when } (\text{floor}(O_i + 0.5) - T_i) = 0, \\ 0 & \text{otherwise} \end{cases} \quad (3)$$

where the function of rounding down is floor(x).

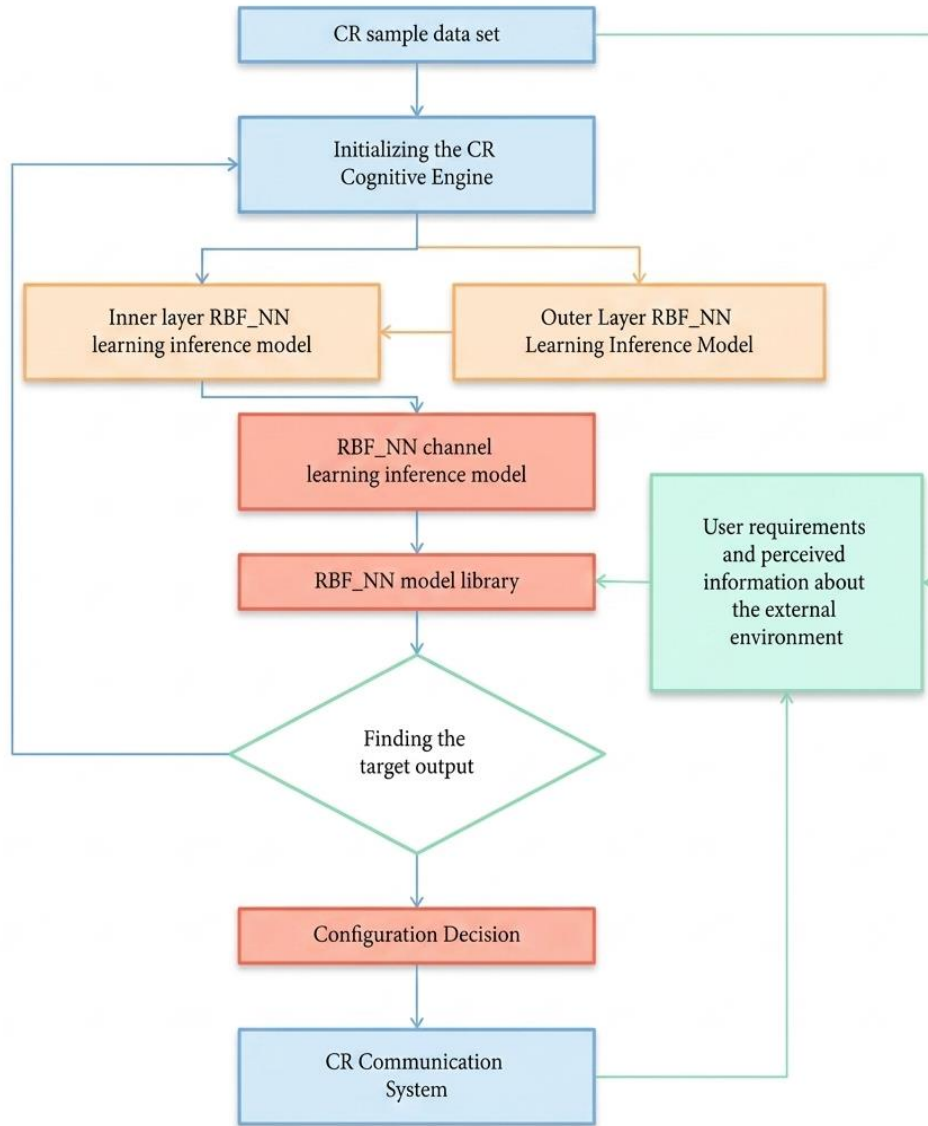


Figure 4. Flow Chart for the RBF Neural Network Cognitive Engine Model

The above Figure 4 Flow chart for the RBF neural network cognitive engine model is examined. Routing configuration in terms of outer neural network has been shown in Tables 1 and 2, MSE and RR data from two different models (BP Model and RBF Model) [19]. The average (MSEaver) and average reliability rating (RRaver) of the BP Model listed in Tables 1 to 7 is 0.0785 and 92.2% respectively, while that of the RBF Model is 0.0230 and 98.8%. The MSE shape indicates that the RBF Model has an increased degree of model stability over the BP Model by 0.0555; thus, the RBF Model provides better prediction performance than does the BP Model. The RR shape shows that the RBF Model has better prediction accuracy (an overall 6.6% greater than BP Model) and is more stable with approximately 98% of all RBF Model predictions being accurate. Because of these results, outer neural networks of the RBF Model can effectively select routing protocols (RPs).

Table 1. MSE measurements for Outer Layer Neural Networks

Model	1	2	3	4	5	6	7	8	9	10
BP	0.06	0.07	0.03	0.10	0.06	0.07	0.04	0.20	0.13	0.05
RBF	0.02	0.05	0.02	0.01	0.03	0.02	0.03	0.02	0.05	0.02

Table 2. RR is the Outer Layer Neural Network Metric.

Model	1	2	3	4	5	6	7	8	9	10
BP	0.87	0.96	0.97	0.95	0.92	0.94	0.93	0.86	0.78	0.94
RBF	0.98	0.97	0.98	0.99	0.98	0.99	0.97	0.99	0.99	0.99

Table 3. MSE of the DSDV Sub-Network Rate of the Inner Layer Neural Network

Model	1	2	3	4	5	6	7	8	9	10
BP	1.40	1.50	1.60	1.10	1.10	1.10	1.20	1.30	1.40	1.50
RBF	0.02	0.03	0.02	0.02	0.04	0.04	0.03	0.01	0.02	0.01

Table 4. MSE of the DSDV Subnet Work CW Inner Neural Network

Model	1	2	3	4	5	6	7	8	9	10
BP	0.23	0.20	0.21	0.22	0.23	0.21	0.23	0.22	0.21	0.20
RBF	0.02	0.03	0.02	0.01	0.01	0.02	0.01	0.03	0.04	0.02

Table 5. MSE of the DSDV Subnet Power Inner Neural Network

Model	1	2	3	4	5	6	7	8	9	10
BP	0.06	0.07	0.04	0.05	0.04	0.03	0.06	0.07	0.08	0.09
RBF	0.02	0.02	0.03	0.02	0.04	0.03	0.04	0.04	0.05	0.03

Table 6. RR of the DSDV Subnetwork Rate Inner Neural Network

Model	1	2	3	4	5	6	7	8	9	10
BP	0.23	0.24	0.20	0.30	0.40	0.35	0.36	0.35	0.40	0.35
RBF	0.99	0.97	0.97	0.98	0.89	0.90	0.97	0.99	0.96	0.99

Table 7. RR of the DSDV Subnet Work CW Inner Neural Network

Model	1	2	3	4	5	6	7	8	9	10
BP	0.54	0.63	0.61	0.50	0.57	0.69	0.58	0.60	0.58	0.70
RBF	0.99	0.98	0.98	0.99	0.98	0.99	0.99	0.98	0.97	0.99

Tables 6 and 7 demonstrate that the average regress rate of RBF is 65.0% more than that of BP and 39.2%, indicating a better success rate for RBF reconfiguration [20].

Legal Management of Public Opinion and the Cognitive Engine

Laws and regulations do have an impact on social life through law enforcement implementing them and through legislation [21]. To provide for a strong and accurate legal order expected by legislators, it is important to establish a network of public opinion monitoring and response agencies to enhance the accountability and effectiveness of law enforcement agencies. The cognitive wireless network “AI Cognitive Engine” developed in this paper will improve the ability of public opinion monitoring network’s ability to accurately identify risks and crises associated with public opinion and will provide the necessary support for achieving accurate law enforcement [22]. Establishing an effective public opinion monitoring platform will be accomplished by using the “human-machine integration” normalized-tracking and monitoring system developed in this paper to improve the monitoring, analysis, and assessment of public opinion, thus enabling law enforcement agencies to have a greater awareness of the ongoing trends of public opinion and to conduct early warning and intervention actions prior to the onset of public opinion crisis events.

5. CONCLUSION

The evolution of the wireless Internet has led to an evolution of how we share ideas and opinions publicly; this has resulted in the use of social media instead of traditional methods for communicating ideas and opinions. This change from traditional methods to new methods has demonstrated that mobile-based platforms, specifically social media, have changed many aspects of daily life for citizens in society and aided significantly in determining how public opinion information is shared and altered and how the method in which we communicate in cyberspace is structured.

With mobile wireless networks providing very real-time feedback, difficult to trace back to the original source, and simple ways to conceal one’s identity while utilizing those networks, many individuals and groups with malicious intent freely use the mobile wireless network to disseminate harmful and destabilizing ideas to the general population, which leads to false public opinion and concealed sources of threat to social stability. The risk associated with different forms of public opinion cannot be easily quantified on either form of Internet, however with the growing use of technology for personal and professional applications, the use of wireless Internet is as widespread as the use of wired Internet. Therefore, monitoring of public opinion through wireless Internet has become increasingly important and urgent. The purpose of this paper is to propose the use of a cognitive engine model utilizing artificial intelligence to identify and monitor public opinion on wireless networks.

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